

Multimedia Communication in a Medical Environment

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ABSTRACT

The possibility of a communication link between medical consultants at different sites to enable them to have a discussion without travelling could be very attractive. In order to have a meaningful discussion they need to share information such as microscope images, X-ray photographs, etc, in addition to the normal voice and video images. This report describes work carried out to provide multimedia communication facilities for two gynaecologists in different hospitals.

1. Introduction

This work described in this paper is part of an international project concerning multimedia communication in a medical environment (MultiMed). It is one of the application pilot projects of the EEC RACE [1] programme and includes some 13 partners from Spain, France, the United Kingdom and Finland.

As a RACE Applications Pilot, MultiMed has endeavoured to meet the communications needs in a chosen application area using the best available technology. Across the project a number of different implementations have tackled

different aspects of the total MultiMed user requirement. It had originally been intended to try to achieve international communication between the separate systems but unfortunately the provision of the ISDN services by the National Authorities was slower coming than was anticipated.

In Finland the experiment was on teleradiology and the use of Picture Archiving and Communication Systems (PACS). In France there were two pilot applications, the first concentrating on annotated patient records, including images from gamma cameras and scanners; the second developing multimedia patient record handling. Both used basic rate ISDN (called RNIS in France). In Spain, the application was in cancer treatment.

The UK experiment was to provide a multimedia communication for two gynaecologists working in different hospitals to enable them to discuss microscope images. This paper describes the UK experiment with emphasis on the design of the communication system and user interface.

2. System Architecture

The basis of the communication system configuration is shown in Fig.1. Communicating sites are connected by ISDN30 and the MATMX

(Model ATM Exchange) provides an ATM interface for application components working above the ISDN layer. A user interface on the UNIX workstation controlled the operation of the video transmitter, receiver and the voice codec. Unfortunately, as will be discussed later, because of financial constraints it was not possible to provide an ISDN link between the hospitals and hence the experiment had to be conducted between two rooms on the same site.

2.1 MATMX

Although ATM (Asynchronous Transfer Mode) has been chosen as the switching fabric for future Broadband ISDN, the current ISDN service presents only a circuit switched subscriber interface. An obvious approach to building a wide area ATM network is to build it on top of primary rate ISDN and this is the approach followed in the project. The MATMX, designed and implemented within this project, is a local exchange which provides subscribers with an ATM interface to access both local and remote subscribers [2]. The interface unit to ISDN30 is the UNISON ramp [3], which supports dynamic setup and management of channels (called U-channels) to other ISDN30 subscribers. A U-channel is composed of an aggregate of B-channels and has a bandwidth which is an integral multiple of 64kb/s. The U-channel bandwidth can be varied dynamically throughout the duration of the channel's existence by the addition or removal of B-channels. The MATMX was constructed using transputers as the main processors because of the ease of interconnection, and the basic subscriber interface is the transputer link.

For historical reasons, the ATM signalling and cell format used in the project are not exactly consistent with CCITT standards since the latter had not been adopted at the time decisions had to be made in the project. However the main concepts are similar.

2.2 Video Transmitter

This unit converts the PAL composite video signal into digital data with sixteen bits used to represent each pixel. Video data are stored in frame memory under the control of a transputer. The maximum image size is 512 lines by 512 pixels. When a frame of an image has been captured, the transputer reads the data, processes them if necessary, assembles them into packets/cells of 40 bytes and transmits them out through the transputer links. The transmitting rate is programmable and the maximum transmitting rate is about one and half colour images of 256 lines by 256 pixels per second.

2.3 Video Receiver

The video receiver performs the reverse function of the transmitter. It receives data from the MATMX, decodes and disassembles them and puts them into display memory. The contents in the display memory are read out continuously to refresh the display. The transmitter is capable of transmitting images of any size up to the maximum of 512 by 512 pixels and the receiver is capable of displaying images at any position on the monitor. Thus several images can be displayed on the receiver monitor at the same time, and typical displays have four

quarter-screen images or a full screen image on the monitor. Details of the user interface are given later. A typical display and the user interface are shown in Fig.2. More detailed information on the video transmitter and receiver can be found in reference [4].

2.4 Voice Codec

The voice codec is also based on transputers. It implements CCITT G.722 SB-ADPCM Wide Band Audio Standard which codes 7 kHz voice into 64kbits/s.

The increased audio bandwidth improves the quality of the speech and helps to provide a more natural environment during communication. Detailed information on the voice codec can be found in reference [5].

2.5 Workstation and User Interface

The workstation used is an Acorn R140 UNIX workstation and the user interface is implemented on it using X windows.

Although the video transmitter and receiver and voice codec are discrete components physically, they are connected via software and their operation is controlled via the user interface. It is essential that the user interface should be as simple as possible in concept and operation, since the equipment was intended for use by operators who would not necessarily be familiar with using computers. Initially the interface was designed around cascading pop-up menus but after two on-site trials at the hospital and considering medical user preference this was modified to a

push-button based interface as is shown in Fig.3. The main concentration of the medical professional is obviously on the medical images under discussion and they should not be distracted by an interface that requires a good deal of concentration and skill in manipulation.

By moving and clicking on the user interface, a user can select image sources, image position, action on images and enable and dis-enable the sound connection. In normal operation, the user enables the sound connection first by clicking on the SOUND button which is then highlighted. The user then selects either MICROSCOPE or CAMERA as the image grabbing source. MICROSCOPE is for transmitting microscope images and CAMERA is for transmitting head and shoulder images of the user. Next, the user selects one of five image displaying positions, top left, top right, bottom left and bottom right quarter-screens and full screen denoted by the centre box. The user then selects and activate one of four functions:

SCAN (starting a slow scan at the position selected and with the selected source),
 FREEZE (stopping a slow scan or transmitting a still image at the selected position and with selected source),
 ERASE (stopping the slow scan and erasing the image displayed at the selected position with selected source) and
 ERASE ALL (stopping all image transmission and erasing images on the display). All buttons except the four function buttons are highlighted when selected.

3. Experiments and User Reactions

It was originally intended to carry out an experiment between the two hospitals in London but, unfortunately because of financial constraints, an ISDN connection could not be made available between the hospitals and the experiment had to be carried out between two rooms in the same hospital. Images taken by the histopathology microscope and head and shoulder images of the gynaecologist were sent over the link. The technology was readily accepted by the medical users as they found it possible to carry out meaningful discussions over the link.

As there was an ISDN connection between Rutherford Appleton Laboratory (RAL) in Oxford and the University of Technology (LUT) in Loughborough a project progress meeting was carried out over the network using the system configuration shown in Fig.1. with three participants at LUT and four at RAL. The meeting achieved its objectives and discussion between sites worked very well.

An interesting point was that the high cost of the communication link caused the participants to keep the discussion well focussed and the business was dealt with in record time!

Some general user reactions were as follows :-

(1) Surprisingly, slow scan video communication using an update rate of only about 1 frame/sec was quite acceptable. The update rate was sufficient to give a feeling of presence and to see user reaction but was not sufficiently fast to raise

expectation of a normal real time image and to create annoyance by the systems failure to achieve this.

(2) A session when only voice communication was provided convinced the participants of the value of the slow scan video in concentrating the attention on the proceedings.

(3) It is important that the colour rendering at the two ends of the link should be the same particularly in a medical environment.

(4) Because it was necessary for the medical professionals to be concentrating on the medical aspects of the discussion it was important to design an interface that was very easy to use.

(5) The split screen facility of the receiver was very useful. For instance the same specimen under study can be shown at different magnifications at different positions on the screen to help discussion.

4. Conclusion

This paper has described a multimedia communication system and the experiments carried out using the system. The general reaction is that the technology is valuable although some improvements to the present design would be beneficial.

Acknowledgement

The authors would like to thank all project members for their support in carrying out the work. Particular thanks are due to Mr. P F Clark, the project manager, the Rutherford Appleton Laboratory team under Mr. J Burren who

developed the MATMX and the Oxford Polytechnic team under Mr. G Tagg for the work in preparing and carrying out the experiments.

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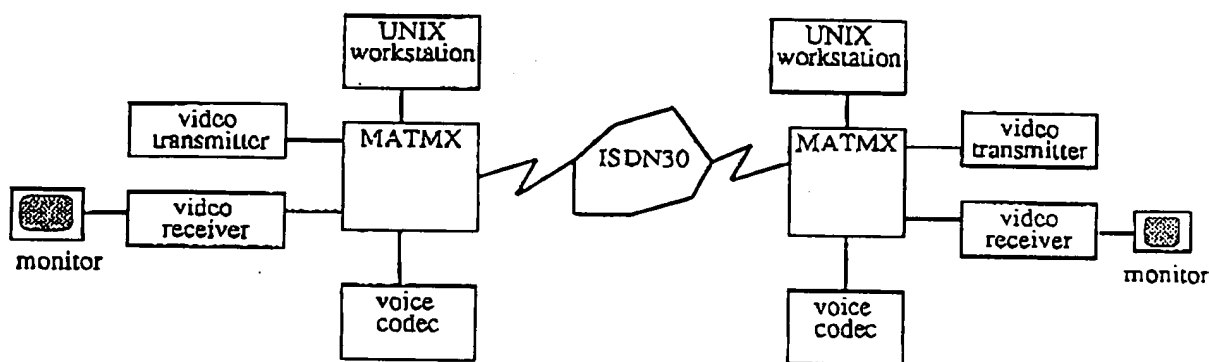


Figure 1. Communication System Configuration



Figure 2. A Typical Display and the User Interface

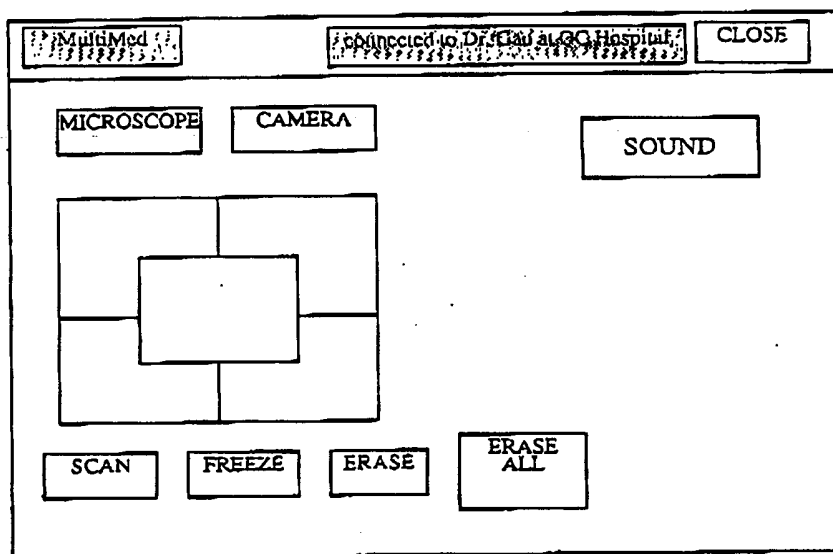


Figure 3. MultiMed User Interface

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1991

PROCEEDINGS OF THE 1991 SINGAPORE INTERNATIONAL CONFERENCE ON NETWORKS

Towards Network Globalisation

September 5 - 6, 1991 Raffles City Convention Centre, Singapore

Edited by G. S. Poo
National University of Singapore



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PROCEEDINGS OF THE 1991 SINGAPORE INTERNATIONAL CONFERENCE
ON NETWORKS — TOWARDS NETWORK GLOBALISATION

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ISBN 981-02-0796-4

Published by

World Scientific Publishing Co. Pte. Ltd.

P O Box 128, Farrer Road, Singapore 9128

USA office: Suite 1B, 1060 Main Street, River Edge, NJ 07661

UK office: 73 Lynton Mead, Tonbridge, London N20 8DH

Printed in Singapore by JBW Printers and Binders Pte. Ltd.